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A COST-EFFECTIVENESS STUDY OF AIR POLLUTION ABATEMENT IN THE NATIONAL CAPITAL AREA

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Summary Statement by Ernst & Ernst to the

Washington, D. C. Air Pollution Abatement Conference

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I. INTRODUCTION

Mr. Presiding Officer, conference members, ladies and gentlemen. My name is Julian O. Kay. I am the partner in charge of the Washington Office of Ernst & Ernst, a public accounting firm.

We will present today the principal results of a contract study for the U.S. Public Health Service to develop, under certain assumptions, broad estimates of the cost of achieving various air quality levels in the Washington metropolitan area.

The study developed and applied a computer program to simulate the overall impact of emission controls on long-term pollution levels. The costs and efficiencies of these controls are based on analysis of data reflecting actual control experience. These data were originally compiled by others and not subject to our independent verification. Our results should therefore be viewed as magnitudes, or general levels, of cost rather than as precise figures. These results, and others which the computer program is capable of providing, can aid in the formulation of approaches to air pollution abatement in the Washington area since they reflect local conditions as expressed by available data on emissions, meteorology, and other relevant factors. A written report, which sets forth the study limitations and assumptions, will shortly be available to enlarge upon the principal results discussed today. Mr. Presiding Officer, this report will be submitted as an exhibit as soon as it becomes available.

I would like now to introduce Mr. Ellison S. Burton of the Washington office of Ernst & Ernst who has been the project director of the study and who will present the study results.

II. SUMMARY OF STUDY RESULTS

Thank you, Mr. Kay. Mr. Presiding Officer, conference members, ladies and gentlemen. My name is Ellison S. Burton. I am a member of the Management Services Division of Ernst & Ernst and the project director of our study for the Public Health Service.

Mr. Kay mentioned that the objective of this study is to develop magnitudes of cost to achieve various air quality levels in the Washington metropolitan area. The numerical data providing the basis for the study have come from agencies of the Federal, state, and local governments, manufacturers of emission control equipment, public utilities, trade associations, fuel suppliers, consultants, and others. These sources are referenced in our exhibit to be submitted. The Public Health Service, in particular, provided for study purposes detailed data on emission sources, all meteorological inputs, and air quality levels.

I'll proceed by describing, first, the pollutants considered in the study; second, what air quality levels were used as a basis for our calculations; third, the emission control alternatives postulated; and last, the estimated cost of abatement approaches based on these alternatives.

The pollutants of interest in this study are the sulfur oxides and suspended particulates whose emissions were quantitated in the Public Health Service emission survey of the Washington area. Other pollutants are not considered.

First slide, please. (Figure II-1)

We are looking at a picture of the estimated pollution levels of the sulfur oxides in the Washington area. These heavy contours are called isointensity lines and connect points of equal yearly average concentrations, in

parts per million (ppm). These lines, and others I will show, are based on the emission survey mentioned. A meteorological model developed by the Public Health Service uses average wind patterns to translate the surveyed emissions into concentrations on the ground at selected receptor points. By adding up the concentrations contributed by all sources to each of the receptor points, the iso-intensity lines can be interpolated. The estimated yearly average concentrations of sulfur oxides shown by these iso-intensity lines range from negligible values to 0.060 ppm.

Next slide, please. (Figure II-2)

These are the estimated concentration levels for suspended particulates based on the meteorological model. The iso-intensity lines here range from 50 micrograms per cubic meter ($\mu Gms/M^3$), as a yearly average, to around 80 $\mu Gms/M^3$.

Next slide, please. (Table II-1)

This table shows several concentration levels for sulfur oxides and particulates. These levels were provided by the Public Health Service as a basis for analysis.

When we choose a pair of levels from this table, we are requiring that our computer program find, within certain constraints, the cost of reducing concentrations so that no receptor point in the meteorological model exceeds the levels chosen.

Now, how do we achieve these levels? The "how" is a complex problem of fuel composition, heat and energy requirements, and emission control technology.

Next slide, please. (Table II-2)

This is a list of the types of stationary emission sources found in the Washington area. These sources emit sulfur oxides and particulates either

from the combustion of fossil fuels for space heating and power generation or from refuse incineration. Washington has few significant industrial process sources. Stationary combustion sources account for over 95% of the sulfur oxides and over 75% of the particulates emitted in this area according to the recent Public Health Service emission survey.

The next slide (Figure II-3) shows emission control alternatives provided in this study for the stationary combustion sources.

This diagram shows the fuel and hardware alternatives for emission control which are available to major combustion sources presently using either coal or residual oil. A major combustion source emits over 100 tons of a pollutant per year. Suppose a source is now burning a high sulfur coal, then there are several paths which can be taken to achieve reduced emission levels. A lower sulfur coal could be substituted with little or no reduction in particulates. To reduce the particulates, a mechanical device, a multiple cyclone, could be installed. Another device, an electrostatic precipitator, could increase particulate reduction to 99.5% for a coal-fired source. Other alternatives were also postulated; for example, retain the present high sulfur, high ash coal but install a stack gas cleaning system. Another possibility is to switch from the coal or residual oil to natural gas. Some alternatives were not considered such as relocation of a source, switching to atomic energy, or building a high smoke stack. For the thousands of small sources in the model, the only alternative stipulated was to substitute a lower sulfur, lower ash fuel of the same type with no mechanical controls.

In reality, no two emission sources are identical and seemingly small differences in physical plant can imply, for some control alternatives, significantly different problems of technical and economic feasibility. For

this reason, control alternatives were matched to the characteristics of each of the major sources listed in the Public Health Service emission survey. Ranges of cost were estimated for each alternative, broken down into cost per B.T.U. for fuels, purchase installation, maintenance and operating costs for mechanical equipment, and boiler conversion costs for switching types of fuels.

Now, we are ready to ask the final question: What is the magnitude of cost to achieve one or another of the air quality levels posed for this study?

Since there is more than one area-wide abatement approach that can be taken in pursuit of an air quality goal, there is more than one answer to the question. Two approaches were simulated in our computer program.

The first approach consisted of restricting fuels to 1% sulfur by weight or less for sulfur oxides abatement. The approach allowed the addition of control alternatives to abate particulates.

Here are the predicted iso-intensity lines for sulfur oxides resulting from such a fuel restriction.

Next slide, please. (Figure II-4)

The highest predicted concentration is a yearly average of 0.034 ppm which, by chance, achieves almost exactly the 0.035ppm level chosen as the highest analysis point for our study. You will recall from the first slide (Figure II-1) that the highest iso-intensity line of sulfur oxides is about 0.060, so the 1% sulfur restriction produces about a 40% reduction of the highest concentration in our model.

Next slide, please. (Figure II-5)

In this slide, consider the shaded portion for a moment, ignoring the other curves shown. The lower left corner of the shaded area estimates the additional annual cost under the 1% sulfur fuel approach in achieving no

concentration higher than 0.034 ppm at any receptor point in the meteorological model. It shows that if each emission source in our model used the least expensive fuel containing 1% sulfur or less, allowing the possibility of switching types of fuels, the estimated additional fuel cost for the whole Washington area would be a minimum of $6,000,000 annually. Although not shown here, if today's variations in fuel costs are applied, the total could reach $10,000,000 annually.

This fuel restriction does not yield any significant reduction in particulate concentrations, however. A maximum concentration of 75 $\mu Gms/M^3$ at a receptor point can be achieved in conjunction with a 1% sulfur restriction for another $7,000,000 annually, giving a total of at least $13,000,000 annually to realize both results.

This curve also shows that without taking other emission control actions, limiting fuels to 1% sulfur will not achieve the lower concentration levels of sulfur oxides posed for the study, 0.025 and 0.015 ppm. (See Table II-1.)

Consider now another approach based on the assumption that every source will undertake some emission control action. In our Washington model we developed for each type of emission source, based on the emission control options stipulated (Figure II-3), a first possible step in emission control, then a second step, a third step, and so on, each step reducing emissions more and also costing more. Up to six steps per source were provided, the last step being the maximum emission control which could be effected by the source for the given control options. If, in the model, all sources move simultaneously from their present level of pollutant emissions to the first step they can take, we can compute both the total concentration reduction and the total cost of these individual actions for the whole metropolitan area. If instead of the first step, all sources take the second step, then a larger

reduction in concentration and a higher total cost is computed. At step six, every source is doing everything it can and we compute both the maximum possible reduction and the maximum possible cost for our model. The steps are ranked for each source according to the logical order in which abatement actions would be taken. Also, a source which already has some emission controls nevertheless has a first step which goes beyond its present level of control. Only a source using natural gas is exempt from further action under this approach.

If, further, within each step of sulfur oxides emission control for each source, we also carry out successive steps of particulate control actions, then we have a basis for calculating area-wide reductions in the concentrations of both pollutants along with the associated annual costs.

The result of doing all this is the other group of curves shown on the previous slide. Same slide, please. (Figure II-5)

(Slide of SO_x and Particulates vs. Cost)

For want of a name, we call these universal abatement curves. The name doesn't imply that all sources reduce pollutant emissions by the same percentage or spend the same amount of money, but only that each source has to do something in unison with all other sources. The lowest curve shows the cost of reducing concentrations of sulfur oxides with no significant reduction in particulates. The top curve shows the cost with maximum particulate reduction.

The first significant item of information from these curves is that the highest point of sulfur oxides concentration can be reduced below 0.015 ppm in the Washington model. It is interesting to note that the estimated additional cost to go from a maximum of 0.025 ppm to 0.015 ppm is about the same amount as the added cost to go from 0.035 to 0.025, $10,000,000 annually.

These curves also show that if each source in our model did everything possible to control both pollutants, no receptor point in our model would have an average yearly concentration higher than about 0.012 ppm for sulfur oxides or 72 $\mu Gms/M^3$ for particulates. This is the maximum reduction possible in our Washington model under any abatement approach. The estimated cost is $43,000,000 annually. A possible reason that a level lower than 72 $\mu Gms/M^3$ is unattainable in our model is that the thousands of small combustion sources of particulates cannot achieve great enough emission control by substituting lower ash fuels of the same type now used, which is the only particulate control alternative stipulated for them. In addition, no control of particulates from mobile sources was included in our model and the receptor point with the highest concentration is located in a high traffic area.

Comparing approaches, under universal abatement the estimated cost of reaching 0.035 ppm and 75 $\mu Gms/M^3$ would be $16,000,000 annually. The corresponding cost under a 1% sulfur fuel restriction would be about $13,000,000 annually, a difference of $3,000,000. Under the conditions assumed, the 1% sulfur fuel restriction would be the lower cost approach to achieving these levels, principally because some sources already using low sulfur fuels would not be required to take any further action. The universal abatement approach requires that all sources reduce emissions.

The analysis also permits us to see what reaching the several air quality levels means to the different classes of emission sources.

To achieve the 0.035 ppm, 75 $\mu Gms/M^3$ levels under the 1% sulfur fuel restriction, power plants incur about 50% of the additional annual cost; the remaining 50% is incurred principally by large and small apartment buildings, office buildings, commercial establishments, and educational institutions.

Next slide, please. (Figure II-6)

Achieving the same pollutant levels under the universal abatement approach results in a significant change in cost distribution with the Federal and other government installations incurring around 20% of the cost whereas their share was negligible under the 1% sulfur fuel restriction. This distribution does not change greatly for the other air quality levels under the universal abatement approach.

In conclusion I would like to note that the costs presented here, and in the exhibit to be submitted, do not take into account future price fluctuations, deterioration of equipment, interest rates, availability of low sulfur fuels, and several other factors which would have to be reckoned with in a precise determination of costs. But subject to these factors and to the reliability of the cost data used, they provide estimates of the magnitude of costs involved and provide comparative data for achieving different levels of air quality. In our exhibit ranges of cost will be provided for most estimates, based on the sources of information reported. The figures presented here lie within those ranges.

It should be emphasized that our results represent answers to the questions asked of the computer program we developed to simulate air pollution abatement in the Washington area. The results have to be modified, of course, for conditions other than those assumed, but the computer program has great flexibility as a total system analysis tool and can be applied to other geographies and other pollution conditions to gain a better understanding of cost-effectiveness relationships.

We hope that the results presented today will be of material use to this conference and can aid in the management of air resources in the National Capital area. Thank you.

TABLE II-1

AIR QUALITY LEVELS FOR
WASHINGTON MODEL

Sulfur Oxides (PPM)	Particulates (uGm/M^3)
0.015	55.0
0.025	65.0
0.035	75.0

TABLE II-2

TYPES OF EMISSION SOURCES

Apartments	Local Government Facilities
Commercial Establishments	Municipal Incinerators
Federal Installations	Open Burning Areas
Heating Plants	Power Plants
Hospitals	Process Industries
Hotels	Universities

Aggregated Small Sources

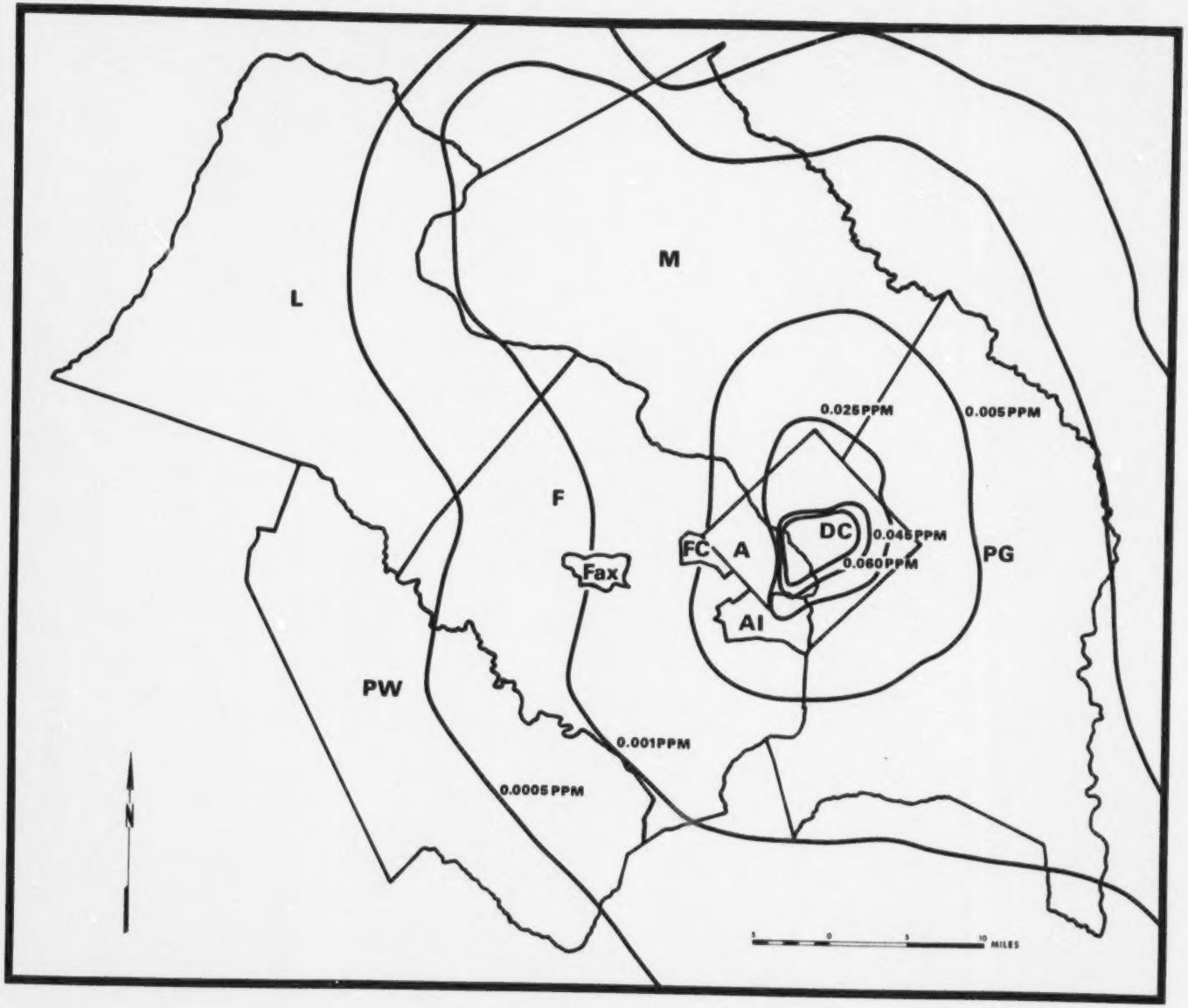

Figure II-1

SULFUR OXIDES

ANNUAL AVERAGE CONCENTRATIONS

LEGEND

———	Iso-intensity Line
PPM	Parts Per Million
A	Arlington County
Al	Alexandria
DC	District Of Columbia
F	Fairfax County
Fax	Fairfax
FC	Falls Church
L	Loudoun County
M	Montgomery County
PG	Prince Georges County
PW	Prince William County

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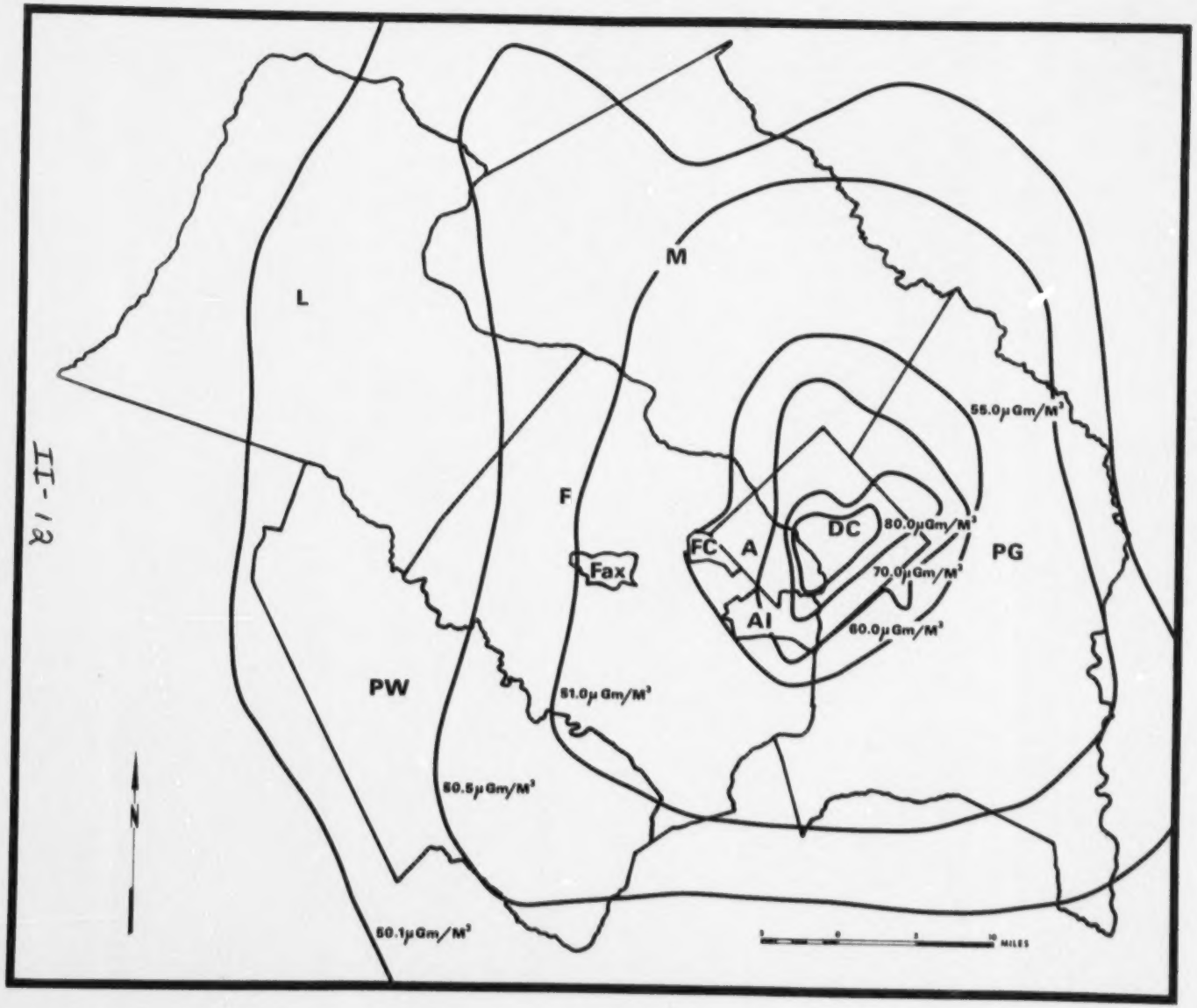

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Figure II - 2

SUSPENDED PARTICULATES ANNUAL AVERAGE CONCENTRATIONS

LEGEND

———	Iso-intensity Line
μGm/M³	Micrograms Per Cubic Meter
A	Arlington County
Al	Alexandria
DC	District Of Columbia
F	Fairfax County
Fax	Fairfax
FC	Falls Church
L	Loudoun County
M	Montgomery County
PG	Prince Georges County
PW	Prince William County

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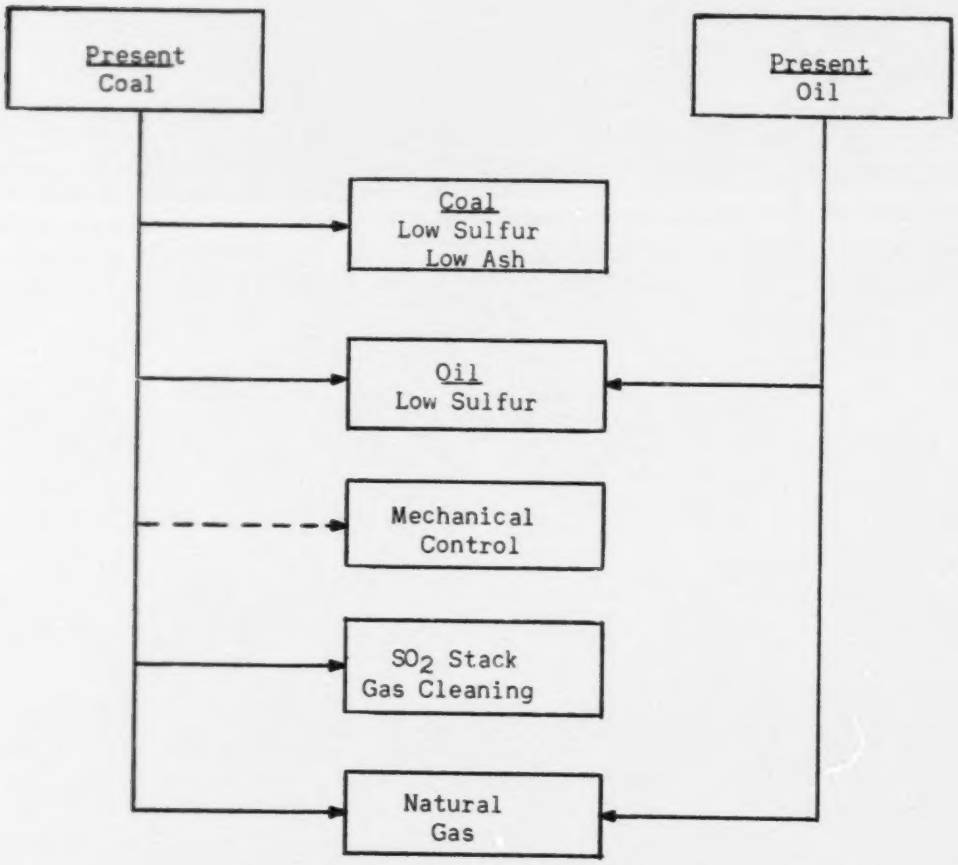
FIGURE II-3

ALTERNATIVES FOR SULFUR OXIDES AND
PARTICULATE EMISSION CONTROL (MAJOR SOURCES)



Reduction of Particulates and SO_x ———

Reduction of Particulates Only - - - - -

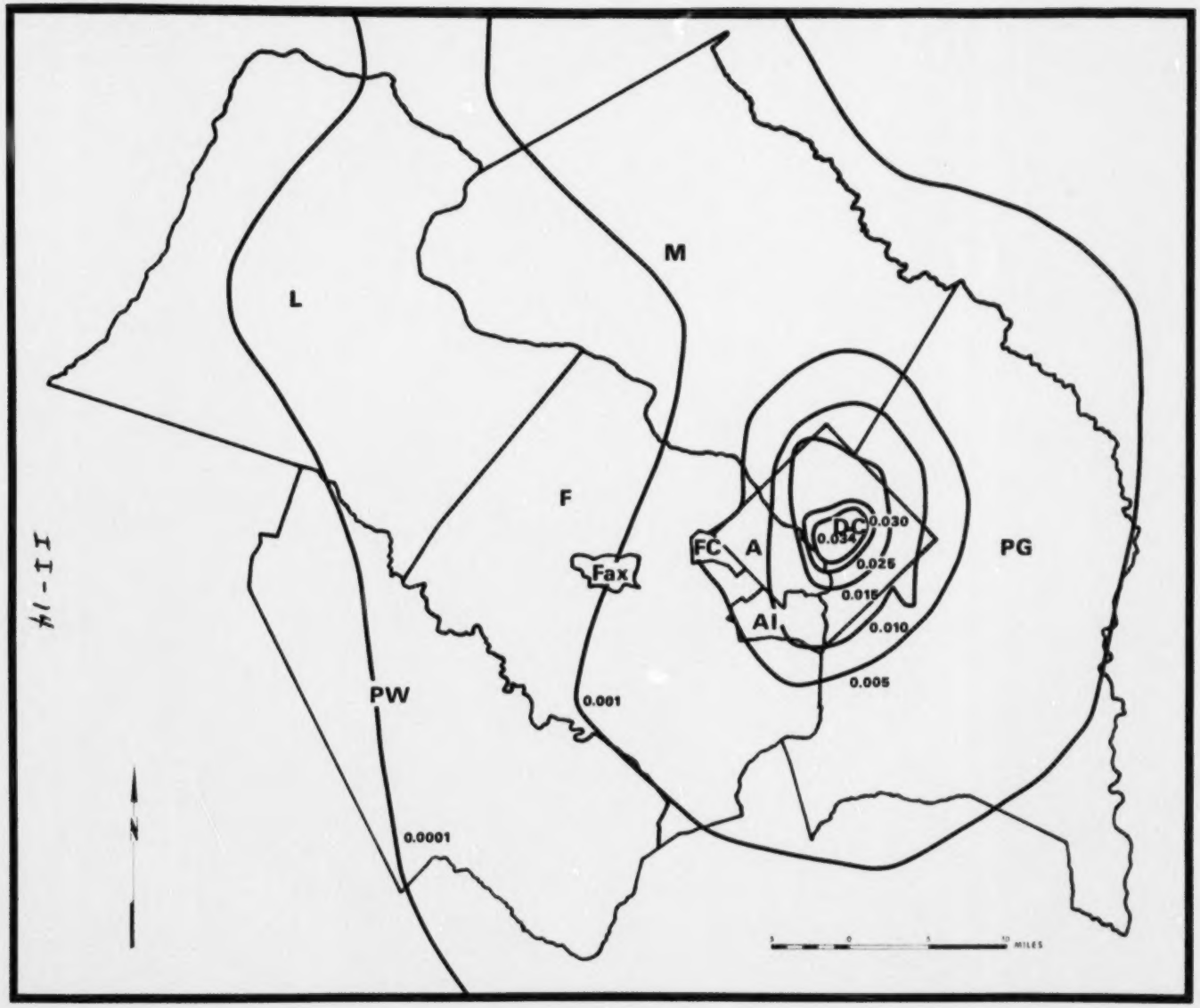


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Figure II-4

SULFUR OXIDES
1% SULFUR FUELS
ANNUAL AVERAGE
CONCENTRATIONS
(PPM)

LEGEND

———	Iso-intensity Line
PPM	Parts Per Million
A	Arlington County
Al	Alexandria
DC	District Of Columbia
F	Fairfax County
Fax	Fairfax
FC	Falls Church
L	Loudoun County
M	Montgomery County
PG	Prince Georges County
PW	Prince William County

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FIGURE II·5

ESTIMATED ADDITIONAL ABATEMENT COST (ANNUAL)

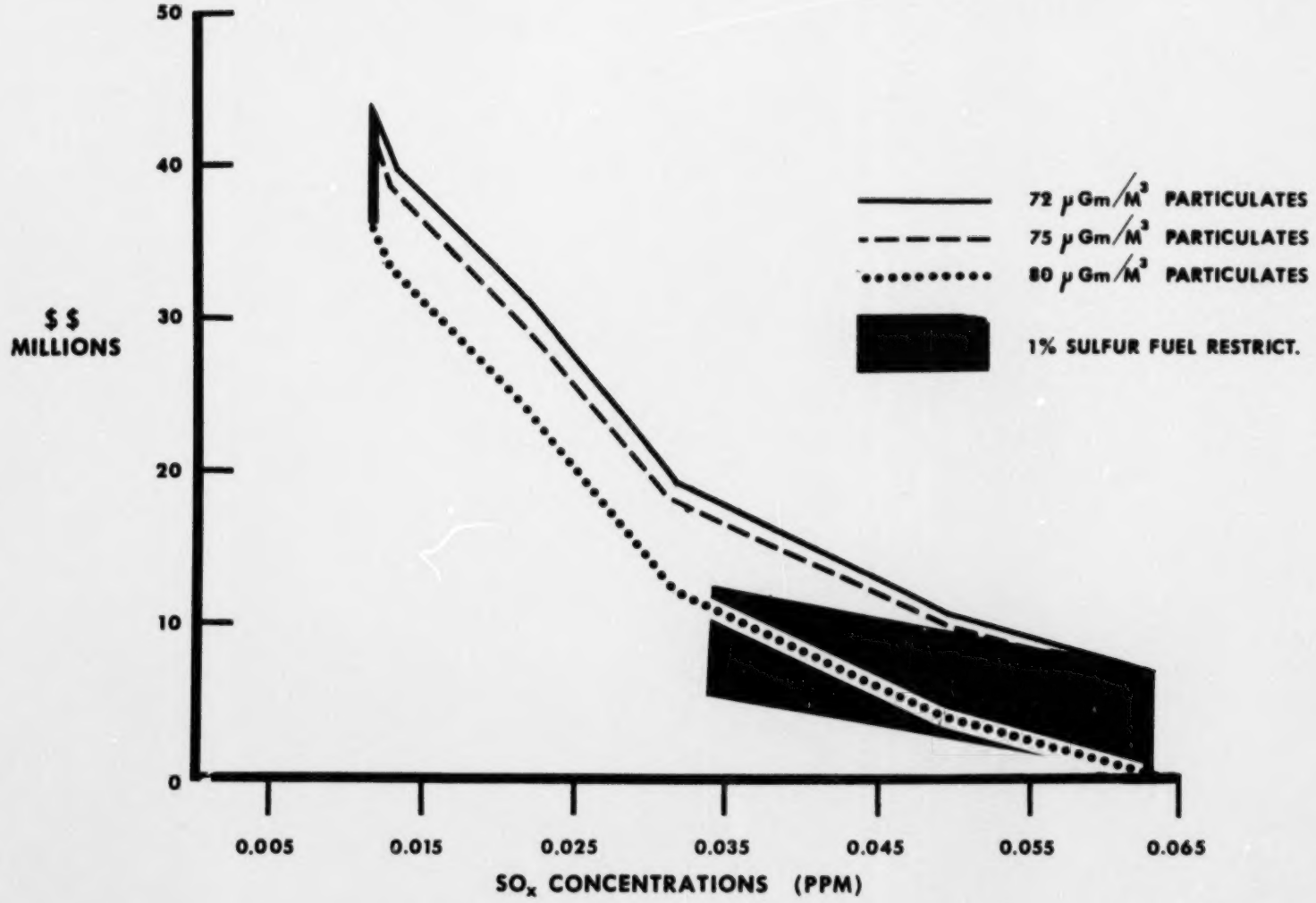
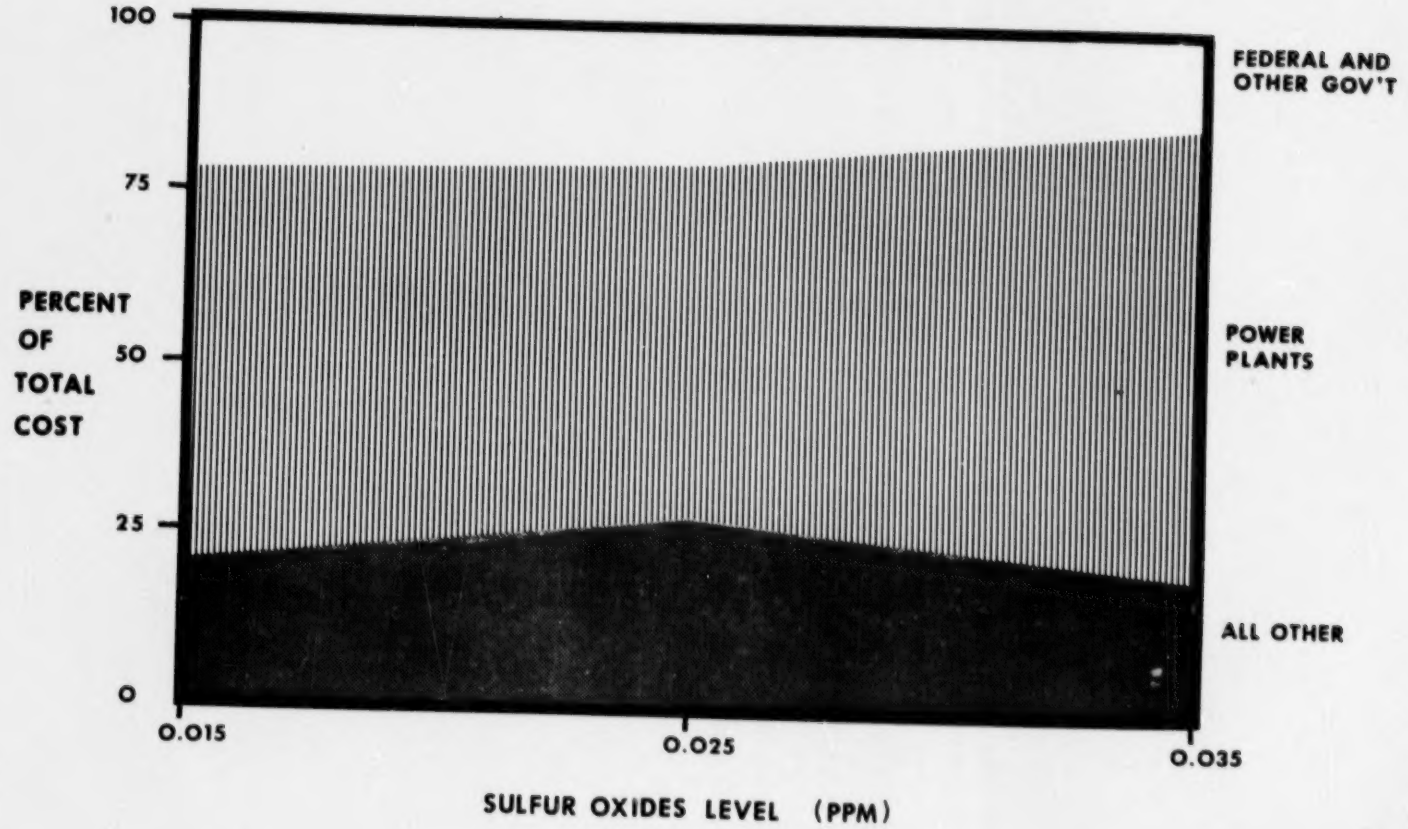


FIGURE II-6

COST DISTRIBUTION FOR SULFUR OXIDES CONTROL AT 75 μGm/M³ PARTICULATE LEVEL (UNIVERSAL ABATEMENT)



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